

AMENDMENT

(Amendment under the provision of Article 11 of Japanese Patent Law)

To: Director-General of Patent Office

1. Indication of International Application:

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4. Date of Amendment Order: 14. 06. 05

5. Subject of Amendment: description and claims

## 6. Contents of Amendment

(1) The description in page 2 lines 6 to 17 (page 3 line 12 to page 4 line 10 in the English version) is amended to "To achieve the above first object --- by means of an inclined surface." as shown in the attached sheets.

(2) The description in page 2 lines 18 to 24 (page 4 lines 11 to 23 in the English version) is amended to "According to a second aspect --- slidably fitted in the guide bore." as shown in the attached sheets.

(3) "More specifically, --- and deposited there." is inserted after "being accumulated and deposited." in page 3 line 16 (page 6 line 8 in the English version) of the description as shown in the attached sheets.

(4) "a guide bore 14" in page 8 line 26 (page 16 line 12 in the English version) of the description is amended to "a guide bore 17" as shown in the attached sheets.

(5) "the tapered step 49" in page 9 line 21 (page 18 line 6 in the English version) of the description is amended to "the tapered step 54" as shown in the attached sheets.

(6) Claim 1 and Claim 2 are amended as shown in the attached sheets.

## 7. List of the attached documents:

(1) Pages 2, 3, 8 and 9 of the description (pages 3, 4, 4/1, 6, 6/1, 16 and 18 in the English version)

(2) Claims in page 13 (pages 24 to 26 in the English version)

[0004] The present invention has been accomplished with such circumstances in view, and it is a first object of the present invention to provide an electromagnetic fuel injection valve, wherein the area of the opposed faces of the stationary core and the movable core can be set at a large value to the utmost and moreover, it is possible to prevent the accumulation and deposition of the chips and the magnetic powder. It is a second object of the present invention to provide a producing process suitable for producing such an electromagnetic fuel injection valve.

#### MEANS FOR SOLUTION OF PROBLEMS

[0005] To achieve the above first object, according to a first aspect of the present invention, there is provided an electromagnetic fuel injection valve, in which a valve member is contained in a valve housing comprising a magnetic cylinder coaxially coupled at a front end thereof to a valve seat member having a valve seat, the valve member being spring-biased in a direction in which the valve member is seated on the valve seat; a non-magnetic cylinder serving as a member different from the magnetic cylinder is coaxially coupled at a front end thereof to a rear end of the magnetic cylinder to surround a portion of a movable core which is coaxially connected to the valve member with a rear end face thereof serving as a movable attraction face; and a front portion of a stationary core having a front end face serving as a stationary attraction face is fitted into and fixed in a rear portion of the non-magnetic

cylinder, so that the stationary attraction face is opposed to the movable attraction face, characterized in that the front portion of the stationary core is fitted and fixed in the non-magnetic cylinder so as to be in close contact with an inner surface of an intermediate portion of the non-magnetic cylinder in a region corresponding to the stationary attraction face, and in the inner peripheral surface of the non-magnetic cylinder, an annular recess having a flat portion flush connected to the stationary attraction face is provided to form an annular chamber between the annular recess and an outer periphery of the rear portion of the movable core, and in the inner peripheral surface of said non-magnetic cylinder, a center bore having an inside diameter larger than an outside diameter of the stationary attraction face is further provided at a location in front of the annular recess, a guide bore is provided in an inner periphery of the magnetic cylinder and flush connected to the center bore of the non-magnetic cylinder, and the annular chamber is formed by continuously connecting the flat portion of said annular recess and the center bore and guide bore by means of an inclined surface.

[0006] According to a second aspect of the present invention, in addition to the arrangement of the first aspect, a guide portion is integrally provided on the movable core having at a rear end face thereof the movable attraction face having an outside diameter substantially equal to that of the stationary attraction face to overhang sideways from the outer periphery

of the movable attraction face, so that the guide portion is slidably fitted in the guide bore.

[0007] To achieve the above second object, according to a third aspect of the present invention, there is provided a process  
5 for producing an electromagnetic fuel injection valve according

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to provide an increase in attraction force. In addition, an annular groove cannot be formed between the stationary core and the non-magnetic cylinder, and the annular chamber is defined between the movable core and the non-magnetic cylinder to surround the outer periphery of the rear portion of the movable core. Therefore, even if chips and a magnetic powder are produced, they can be fluidized and thus, can be prevented from being accumulated and deposited. More specifically, the annular recess forming the annular chamber between the rear outer periphery of the movable core and the annular recess is to be formed at the inner peripheral surface of the non-magnetic cylinder serving as a member different from the magnetic cylinder, and therefore, even if the annular recess is formed, the magnetic characteristic of the structure surrounding this annular recess is not changed. Further, the annular recess is formed to have a flat portion flush connected to the stationary attraction face of the stationary core, and the center bore having an inside diameter larger than an outside diameter of the stationary attraction face is provided in an inner periphery of the non-magnetic cylinder at a location in front of the annular recess, and on the other hand, the guide bore is provided in the inner periphery of the magnetic cylinder coaxially connected at the front end and the rear end of the non-magnetic cylinder and is flush connected to the center bore of the non-magnetic cylinder, and the annular chamber is formed by continuously connecting the flat portion of the annular recess and the center

bore and guide bore by means of an inclined surface. Therefore, the above-described chips and magnetic powder are fluidized on smooth continuous surfaces including the inclined surface of the annular recess formed in the non-magnetic cylinder and can extremely effectively be prevented from being accumulated and deposited there.

[0009] With the second feature of the present invention, an attraction force can be further increased by setting the outside diameter of the movable attraction face at a value substantially equal to that of the stationary attraction face. Moreover, the movable core is guided in the guide bore in the magnetic cylinder and hence, it is possible to provide an enhancement in attraction responsiveness.

[0010] With the third feature of the present invention, when the front portion of the stationary core blank is fitted into and fixed in the non-magnetic cylinder blank, an operation of fitting and fixing the stationary core blank in the non-magnetic cylinder blank is easy, because the stationary core blank has the chamfer around its outer periphery at its front end. Moreover, the stationary attraction face, the annular recess, the center bore and the guide bore are formed by the grinding of the stationary core blank, the non-magnetic cylinder blank and the magnetic cylinder blank, and hence, a dust such as chips produced by the fitting and the chamfer can be removed by the

and the non-magnetic cylinder blank 26' is formed into the cylindrical shape having the inner periphery increased in diameter at the three stages in the rearward direction.

[0034] After the coupling of the stationary core blank 22',

5 the non-magnetic cylinder blank 26' and the magnetic cylinder blank 9' as described above, the front portion of the smaller-diameter tube portion 22a' of the stationary core blank 22' is ground to remove the chamfer 48, whereby a flat stationary

( ) attraction face 42 is formed, and the inner peripheries of the  
10 non-magnetic cylinder blank 26' and the magnetic cylinder blank 9' are subjected to a grinding treatment, whereby an annular recess 44, a center bore 46 and a guide bore 17 are formed.

[0035] Referring again to Fig. 2, the recess 50 having the annular step 49 facing rearwards at its inner end is provided in the  
15 inner periphery of the rear portion of the movable core 18, and the ring-shaped stopper 28 is press-fitted into the recess 50 in such a manner that its front end abuts against the step 49. A flat abutment face 51 is disposed at a location displaced from the flat movable attraction face 41 formed at the rear  
20 end of the movable core 18 toward the stationary attraction face 42, and is formed to be able to abut against the stationary attraction face 42 at the rear end of the stopper 28. A slant 52 is formed in a tapered shape or an arcuate shape on the inner periphery of the rear end of the movable core 18 and the outer  
25 periphery of the rear end of the stopper 28 to connect continuously and smoothly the movable attraction face 41 and the abutment



face 51 to each other.

[0036] Referring to Fig. 4, to couple the stopper 28 to the movable core 18, at first, a cylindrical movable core blank 18' and a ring-shaped stopper blank 28' having shapes shown by dashed lines in Fig. 4 are prepared in order to form the movable core 18 and the stopper 28, respectively.

[0037] The movable core blank 18' is formed into a cylindrical shape extending longer rearwards than the movable core 18 to be formed. Provided in an inner periphery of a rear portion of the movable core blank 18' are a smaller-diameter bore 50' corresponding to the recess 50 in the movable core 18 to form an annular step 49 at an inner end, and a larger-diameter bore 53 which is formed at a diameter larger than that of the smaller-diameter bore 50' and which is coaxially connected to a rear end of the smaller-diameter bore 50' and opens into a rear end of the movable core blank 18', so that the smaller-diameter bore 50' is longer than the recess 50. A tapered step 54 is formed between the smaller-diameter bore 50' and the larger-diameter bore 53. On the other hand, the stopper blank 28' is also axially longer than the stopper 28 to be formed, and a tapered chamfer 55 is provided around an outer periphery of a front end of the stopper blank 28'.

[0038] Then, the front end of the stopper blank 28' is press-fitted into the smaller-diameter bore 50' in the rear portion of the movable core blank 18', until the front end of the stopper blank 28' abuts against the step 49. In this case, an operation of

press-fitting the stopper blank 28' into the smaller-diameter bore 50' in the rear portion of the movable core blank 18' is easy, because the rear end of the smaller-diameter bore 50' is connected to the larger-diameter bore 53 opening into the rear end of the movable core blank 18' through the tapered step 54, and the chamfer 55 is provided around the outer periphery of the front end of the stopper blank 28'.

[0039] After press-fitting of the stopper blank 28' into the rear portion of the movable core blank 18', the rear ends of the stopper blank 28' and the movable core blank 18' are ground, whereby a movable attraction face 41, an abutment face 51 and a slant 52 are formed. In addition, the rear portion of the stopper blank 28' and the rear portion of the movable core blank 18' are cut off, and the recess 50 is formed by a portion of the smaller-diameter bore 50'.

[0040] Next, the operation of this embodiment will be described below. The front portion of the stationary core 22 is fitted and fixed in the non-magnetic cylinder 26 in such a manner that it is in close contact with the inner surface of the intermediate portion of the non-magnetic cylinder 26 in the region corresponding to the stationary attraction face 42, and the annular recess 44 having the flat portion 44a flush connected to the stationary attraction face 42 is provided in the inner surface of the non-magnetic cylinder 26, so that the annular chamber 45 is defined between the annular recess 44 and the outer periphery of the rear portion of the movable core 18.

## CLAIMS

[1] (amended) An electromagnetic fuel injection valve, in which a valve member (20) is contained in a valve housing (8) comprising a magnetic cylinder (9) coaxially coupled at a front end thereof to a valve seat member (10) having a valve seat (13), said valve member (20) being spring-biased in a direction in which said valve member (20) is seated on said valve seat (13); a non-magnetic cylinder (26) serving as a member different from said magnetic cylinder (9) is coaxially coupled at a front end thereof to a rear end of the magnetic cylinder (9) to surround a portion of a movable core (18) which is coaxially connected to said valve member (20) with a rear end face thereof serving as a movable attraction face (41); and a front portion of a stationary core (22) having a front end face serving as a stationary attraction face (42) is fitted into and fixed in a rear portion of said non-magnetic cylinder (26), so that said stationary attraction face (42) is opposed to said movable attraction face (41), characterized in that the front portion of said stationary core (22) is fitted and fixed in said non-magnetic cylinder (26) so as to be in close contact with an inner surface of an intermediate portion of said non-magnetic cylinder (26) in a region corresponding to said stationary attraction face (42), and in the inner peripheral surface of said non-magnetic cylinder (26), an annular recess (44) having a flat portion (44a) flush connected to said stationary attraction face (42) is provided to form an annular chamber (45) between said annular recess

(44) and an outer periphery of the rear portion of said movable core (18), and in the inner peripheral surface of said non-magnetic cylinder (26), a center bore (46) having an inside diameter larger than an outside diameter of said stationary attraction face (42) is further provided at a location in front of said annular recess (44), a guide bore (17) is provided in an inner periphery of said magnetic cylinder (9) and flush connected to said center bore (46) of the non-magnetic cylinder (26), and said annular chamber (45) is formed by continuously connecting said flat portion (44a) of said annular recess (44) and said center bore (46) and guide bore (17) by means of an inclined surface.

[2] (amended) An electromagnetic fuel injection valve according to claim 1, wherein a guide portion (47) is integrally provided on said movable core (18) having at a rear end face thereof said movable attraction face (41) having an outside diameter substantially equal to that of said stationary attraction face (42) to overhang sideways from the outer periphery of said movable attraction face (41), so that said guide portion (47) is slidably fitted in said guide bore (17).

[3] A process for producing an electromagnetic fuel injection valve according to claim 1, comprising a step of preparing a cylindrical magnetic cylinder blank (9') and a non-magnetic cylinder blank (26') for forming said magnetic cylinder (9) and said non-magnetic cylinder (26), respectively, as well as a stationary core blank (22') having a chamfer (48) around the

outer periphery at a front end thereof for forming said stationary core (22); a step of fixing said stationary core blank (22') to said non-magnetic cylinder blank (26') in a state in which a front portion of said stationary core blank (22') has been  
5 fitted so as to be in close contact with an inner surface of an intermediate portion of said non-magnetic cylinder blank (26') coaxially coupled to said magnetic cylinder blank (9'); and a step of grinding the front portion of said stationary  
core blank (22') so as to remove said chamfer (48), thereby  
10 forming a flat stationary attraction face (42), and subjecting inner peripheries of said non-magnetic cylinder blank (26') and said magnetic cylinder blank (9') to a grinding to form said annular recess (44), said center bore (46) and said guide bore (14), the above steps being carried out sequentially.